PATENT ABSTRACTS OF JAPAN

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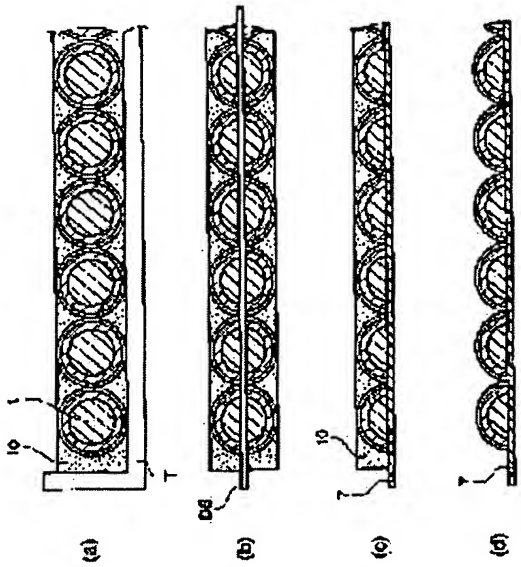
(54) METHOD OF CUTTING GLOBULAR BODY, AND SOLAR BATTERY USING THE GLOBULAR BODY AND METHOD OF MANUFACTURING THE SAME

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a solar battery which has a high reliability and can be reduced in size and can be easily formed with contacts and has a little variation in characteristics by precisely and efficiently cutting globular bodies.

SOLUTION: A method of manufacturing the solar battery includes a process of spreading globular bodies in a row all over a tray, a process of filling the tray with resin and then hardening the resin together with the spread globular bodies to fasten these globular bodies into one unit, a process of positioning the globular bodies while they are fastened with the resin and then cutting the globular bodies so that a cutting face may pass through the center of each globular body, a process of pasting a tape onto the cutting face, and a process of removing the resin while the globular bodies are fixed with the tape to form semi-globular bodies.



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CLAIMS

[Claim(s)]
[Claim 1] The process which covers a single tier with a sphere at a tray, and the process which is filled up with resin in said tray, is made to harden with the sphere with which it was covered, and fixes many spheres in one. The process cut with resin so that the cutting plane which positions in the condition of having fixed by resin and passes along each spherical core may be formed, The manufacture approach of the hemisphere characterized by including the process which sticks a tape on this cutting plane, and the process which removes said resin and forms a hemisphere, fixed on said tape.
[Claim 2] The semi-conductor layer of the 2nd conductivity type formed so that pn junction might be formed in the spherical substrate front face on which a front face constitutes the semi-conductor layer of the 1st conductivity type at least, The process which prepares many cels in which the ground electrode which consists of transparence electric conduction film formed in said 2nd semi-conductor layer front face was formed, The process which covers a single tier with said cel at a tray, and the process which is filled up with resin in said tray, is made to harden with the cel with which it was covered, and fixes many photovoltaic cells in one, The process cut with resin so that the cutting plane which positions in the condition of having fixed by resin and passes along the core of each cel may be formed, The manufacture approach of the solar battery characterized by including the process which sticks a tape on this cutting plane, and the process which forms an electrode so that said resin may be removed and the semi-conductor layer of said 1st conductivity type may be contacted, fixed on said tape.
[Claim 3] The semi-conductor layer of the 2nd conductivity type formed so that pn junction might be formed in the spherical substrate front face on which a front face constitutes the semi-conductor layer of the 1st conductivity type at least, The process which prepares many cels in which the ground electrode which consists of transparence electric conduction film formed in said 2nd semi-conductor layer front face was formed, The process which covers a single tier with said cel at a tray, and the process which is filled up with resin in said tray, is made to harden with the cel with which it was covered, and fixes many photovoltaic cells in one, The process cut with resin so that the cutting plane which positions in the condition of having fixed by resin and passes along the core of each cel may be formed, The process which arranges horizontally two or more cels stuck on said tape so that said cel may be located upwards, The process which sprinkles resin fine particles from the top face of said cel, and the process which heats said cel and fixes between said cels and said tapes in a resin layer, The manufacture approach of the solar battery characterized by including the process which furthermore sprinkles solder fine particles, the process which heats said cel, liquefies said solder fine particles, and fixes between said cels and said tapes with solder, and the process which removes said tape and fixes an electric conduction plate.
[Claim 4] The manufacture approach of the solar battery according to claim 3 characterized by including the process which dopes the high-concentration 1st conductivity-type impurity from the rear-face side of said semi-sphere in advance of the process which fixes said electric conduction plate.
[Claim 5] Furthermore, the manufacture approach of the solar battery according to claim 4 characterized by including the process which forms a protective coat on said electric conduction plate.
[Claim 6] The hemispherical substrate with which a front face constitutes the semi-conductor layer of the 1st conductivity type at least, and the semi-conductor layer of the 2nd conductivity type formed so that pn junction might be formed in said ball front face, The solar battery characterized by providing the electric conduction plate as the ground electrode which consists of transparence electric conduction film formed in said 2nd semi-conductor layer front face, and an inside electrode formed in the base of said hemispherical substrate, and making insulating resin intervene between the edge of said ground electrode, and said electric conduction plate.
[Claim 7] The electric conduction plate as an inside electrode, and the hemispherical substrate with which a front face constitutes the semi-conductor layer of the 1st conductivity type at least, The semi-conductor

layer of the 2nd conductivity type formed so that pn junction might be formed in said ball front face, It is arranged so that two or more semi-sphere cels which come to provide the ground electrode which consists of transparence electric conduction film formed in said 2nd semi-conductor layer front face may touch said electric conduction plate front face in the base. The solar battery characterized by forming a conductor layer in the field located between said cels of said electric conduction plate front face through insulating resin, and making the electrical installation of said ground electrodes through this conductor layer.

[Claim 8] Said hemispherical substrate is a solar battery according to claim 7 characterized by coming to form pn junction between the silicon layers of the 2nd conductivity type which consisted of a half-silicon ball of the 1st conductivity type, and was formed in the front face of said half-silicon ball.

[Claim 9] It is the solar battery according to claim 7 characterized by for said hemispherical substrate consisting of a metal spherule, forming in the ball front face of said hemispherical object the silicon layer of the 1st conductivity type, and the silicon layer of the 2nd conductivity type formed in the silicon layer front face of said 1st conductivity type, coming to form pn junction, and forming said electric conduction plate so that the base of said hemisphere may be contacted.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to cutting process, the spherical solar battery using this, and its spherical manufacture approach, and relates to the solar battery especially using a hemispherical semi-conductor.
[0002]
[Description of the Prior Art] The electron and electron hole which were generated when the internal field has arisen into the pn junction part of a semi-conductor, light is applied to this and the electron-hole pair was made to generate are separated by the internal field, an electron is brought together in the n side, an electron hole is brought together in the p side, and if a load is connected outside, a current will flow towards the n side from the p side. This effectiveness is used and utilization of a solar battery is advanced as a component which transforms light energy into electrical energy.
[0003] In recent years, the technique of forming a circuit pattern on a spherical semi-conductor (Ball Semiconductor) with a diameter [of single crystal silicon polycrystalline silicon, etc.] of 1mm or less, and manufacturing a semiconductor device is developed.
[0004] The manufacture approach of the solar array which connected many semi-conductor particles, using aluminum foil as one is proposed (JP,6-13633,A). By this approach, as shown in drawing 9 , the semi-conductor particle 207 which has the 1st conductivity-type epidermis section and the interior of the 2nd conductivity type is arranged so that it may project from the both sides of aluminum foil 201 in opening of aluminum foil, the epidermis section 209 of one side is removed, and an insulating layer 221 is formed. Next, the part inside [111] the 2nd conductivity type and the insulating layer 221 on it are removed, and the 2nd aluminum foil 219 is combined with the removed field 217. The flat field 217 offers good ohmic contact to the 2nd aluminum foil 219 as a current carrying part.
[0005]
[Problem(s) to be Solved by the Invention] However, by such approach, there was a limitation in high density arrangement, and positioning to aluminum foil was difficult, and when many semi-conductor particles were mounted, there was a problem that especially workability was bad.
[0006] Moreover, although the contact terminal the 1st conductivity-type epidermis section and inside [both] the 2nd conductivity type was required also about formation of an electrode, there was a problem that it was difficult to form a positive contact terminal, without decreasing light-receiving area.
[0007] Some outside fields were removed by approaches, such as polish, further again, although the approach of forming an electrode in the exposed field was proposed, by such approach, the diffusion layer of a different conductivity type lived together in the same field, and there was a problem that it was difficult to take these out independently.
[0008] Furthermore, in case a hemispherical substrate was formed, positioning was very difficult and cutting of high degree of accuracy was impossible.
[0009] This invention was made in view of said actual condition, and is reliable, and it aims at offering the possible solar battery of a miniaturization.
[0010] Moreover, contact formation is easy and this invention aims to let it offer the small solar battery of dispersion in a property.
[0011] Moreover, this invention aims at offering a scale and an efficient solar battery for improvement in the electromotive force per unit area. Furthermore, this invention aims at cutting a sphere efficiently to high degree of accuracy.
[0012]
[Means for Solving the Problem] It is the process to which the 1st covers a tray with the sphere of this

invention at a single tier. The process which is filled up with resin in said tray, is made to harden with the sphere with which it was covered, and fixes many spheres in one, It is characterized by including the process cut with resin so that the cutting plane which positions in the condition of having fixed by resin and passes along each spherical core may be formed, the process which sticks a tape on this cutting plane, and the process which removes said resin, fixed on said tape, and forms a hemisphere.
[0013] It becomes possible by according to this configuration, making it align in the maximum dense arrangement condition, where a tray is covered with a sphere, and hardening this by resin to cut to high degree of accuracy extremely by fixing with a sufficient location precision and cutting this collectively.
[0014] And a hemisphere can be obtained in the state of alignment by fixing a cutting plane on a tape etc. after cutting, and removing resin. In addition, the semi-conductor ball element assembly itself, such as a single-crystal-silicon ball or a polycrystalline silicon ball, is sufficient as such a hemisphere, and the semiconductor device which semiconductor devices, such as diode, made and was full is sufficient as it.
[0015] The semi-conductor layer of the 2nd conductivity type formed so that pn junction might be formed in the spherical substrate front face on which a front face constitutes the semi-conductor layer of the 1st conductivity type at least according to the 2nd of this invention, The process which prepares many cels in which the ground electrode which consists of transparence electric conduction film formed in said 2nd semi-conductor layer front face was formed, The process which covers a single tier with said cel at a tray, and the process which is filled up with resin in said tray, is made to harden with the cel with which it was covered, and fixes many photovoltaic cells in one, The process cut with resin so that the cutting plane which positions in the condition of having fixed by resin and passes along the core of each cel may be formed, It is characterized by including the process which sticks a tape on this cutting plane, and the process which forms an electrode so that said resin may be removed fixed on said tape and the semi-conductor layer of said 1st conductivity type may be contacted.
[0016] It becomes possible extremely by fixing with a sufficient location precision and cutting this collectively to obtain a hemisphere to high degree of accuracy by making it align in the maximum dense arrangement condition, where a tray is covered with the sphere in which pn junction and a ground electrode were formed according to this configuration, and hardening this by resin.
[0017] And a hemisphere can be obtained in the condition of having aligned at high degree of accuracy, by fixing a cutting plane on a tape etc. after cutting, and removing resin. And by forming the electric conduction plate as an inside electrode in this, the efficient solar battery which consists of a hemisphere by which the maximum dense arrangement was carried out can be formed with sufficient productivity.
[0018] Since the two divided aggregates are used as every one solar battery, respectively, there is no futility in an ingredient and they become what also has very high productivity further again.
[0019] Moreover, according to this approach, a mask process is unnecessary. Although an exposure process is very difficult for especially the photolithography process to a spherule, according to the approach of this invention, it becomes possible to form a very efficient solar battery, without needing a photolithography process.
[0020] The semi-conductor layer of the 2nd conductivity type formed so that pn junction might be formed in the spherical substrate front face on which a front face constitutes the semi-conductor layer of the 1st conductivity type at least according to the 3rd of this invention, The process which prepares many cels in which the ground electrode which consists of transparence electric conduction film formed in said 2nd semi-conductor layer front face was formed, The process which covers a single tier with said cel at a tray, and the process which is filled up with resin in said tray, is made to harden with the cel with which it was covered, and fixes many photovoltaic cells in one, The process cut with resin so that the cutting plane which positions in the condition of having fixed by resin and passes along the core of each cel may be formed, It has fixed on the process which sticks a tape on this cutting plane, and said tape. The process which arranges horizontally two or more cels which removed said resin and were stuck on said tape so that said cel may be located upwards, The process which sprinkles resin fine particles from the top face of said cel, and the process which heats said cel and fixes between said cels and said tapes in a resin layer, It is characterized by including the process which furthermore sprinkles solder fine particles, the process which heats said cel, liquefies said solder fine particles, and fixes between said cels and said tapes with solder, and the process which removes said tape and fixes an electric conduction plate.
[0021] According to this configuration, in addition to said 2nd effectiveness, the resin included in the clearance between the cels which constitute a solar battery is fused. After fixing in a resin layer, while fusing solder powder further, fixing both photovoltaic cells and . which is made to perform electrical installation between ground electrodes, therefore a resin layer contribute to the insulation with an electric conduction plate and a ground electrode Since the connection resilience between hemispheres is raised with the solder layer, a reliable solar battery can be obtained.
[0022] Although a hemisphere [a little] smaller than a semi-sphere is formed with the cutting waste in a

cutting process, few gaps are formed between hemispheres by this, and when resin enters this gap, the effectiveness that the insulation with the electric conduction plate used as a ground electrode and an inside electrode becomes a positive thing also takes effect further again.
[0023] According to the 4th of this invention, it is characterized by including the process which dopes the high-concentration 1st conductivity-type impurity from the rear-face side of said semi-sphere in advance of the process which fixes said electric conduction plate.
[0024] According to this configuration, since a high concentration field is formed between an electric conduction plate and the 1st conductivity-type semi-conductor layer, contact nature will become high. Moreover, when the back sir FISU field effectiveness can also take effect, on the occasion of formation of this high concentration layer, a photolithography process is unnecessary.
[0025] According to the 5th of this invention, in the manufacture approach of a solar battery according to claim 4, it is characterized by including further the process which forms a protective coat on said electric conduction plate.
[0026] According to this configuration, dependability improves by existence of a protective coat.
[0027] The hemispherical substrate with which a front face constitutes the semi-conductor layer of the 1st conductivity type at least according to the 6th solar battery of this invention, The semi-conductor of the 2nd conductivity type formed so that pn junction might be formed in said ball front face, The electric conduction plate as the ground electrode which consists of transparence electric conduction film formed in said 2nd semi-conductor layer front face, and an inside electrode formed in the base of said hemispherical substrate is provided, and it is characterized by making insulating resin intervene between the edge of said ground electrode, and said electric conduction plate.
[0028] According to this configuration, light-receiving effectiveness becomes possible [obtaining a high solar battery with high luminous efficiency] with the minimum ingredient.
[0029] The hemispherical substrate with which a front face constitutes the semi-conductor layer of the 1st conductivity type at least with the electric conduction plate as an inside electrode according to the 7th of this invention, The semi-conductor layer of the 2nd conductivity type formed so that pn junction might be formed in said ball front face, It is arranged so that two or more semi-sphere cels which come to provide the ground electrode which consists of transparence electric conduction film formed in said 2nd semi-conductor layer front face may touch said electric conduction plate front face in the base. A conductor layer is formed in the field located between said cels of said electric conduction plate front face through insulating resin, and it is characterized by making the electrical installation of said ground electrodes through this conductor layer. According to this configuration, dimensional accuracy can obtain the solar battery of the maximum dense arrangement structure highly.
[0030] Moreover, an insulating layer will intervene between the electric conduction plates by the side of a ground electrode and an inside electrode, there is also no fear of a short circuit, and it becomes possible to form a reliable solar battery.
[0031] According to the 8th of this invention, in a solar battery according to claim 7, said hemispherical substrate consists of a silicon ball of the 1st conductivity type, and is characterized by coming to form pn junction between the silicon layers of the 2nd conductivity type formed in the front face of said silicon ball.

[0032] According to the 9th of this invention, in a solar battery according to claim 7, said hemispherical substrate consists of a metal spherule, form in the ball front face of said hemispherical object the silicon layer of the 1st conductivity type, and the silicon layer of the 2nd conductivity type formed in the silicon layer front face of said 1st conductivity type, it comes to form pn junction, and said electric conduction plate is characterized by being formed so that the base of said hemisphere may be contacted.
[0033]
[Embodiment of the Invention] Next, it explains to a detail, referring to a drawing about the gestalt of operation of this invention. The solar battery of the 1st operation gestalt of
 operation gestalt 1 this invention As general drawing is shown in drawing 1 and a cross-section schematic diagram is shown in drawing 2 , the photovoltaic cell 1 which consists of hemispherical silicon The maximum dense array is carried out on the electric conduction plate 5 which consists of a copper plate as an inside electrode, it is made to fix a base, and electrical installation and immobilization are made by the solder layer 3 by which the ground electrode was formed in the field between the cels 1 on the electric conduction plate 5 through the resin layer 4. Namely, the hemispherical substrate 11 which consists of single crystal silicon of p mold and n mold polycrystalline silicon layer 12 formed so that pn junction might be formed in the ball front face of said hemispherical substrate, It is arranged so that two or more semi-sphere cels which come to provide the ground electrode 13 of the transparence which consists of indium oxide tin (ITO) formed in n mold polycrystalline silicon layer 12 front face may touch said electric conduction plate 5 front face in the base. The solder layer 3 is formed in the field located between said cels of said electric conduction plate 5

front face through the insulating resin layer 4, and the electrical installation of said ground-electrode 13 comrades is made through this solder layer 3.

[0034] Next, the manufacture approach of this solar battery is explained. First, a photovoltaic cell is formed. It is made to fall, heating p mold polycrystalline silicon grain with a diameter of 1mm or p mold amorphous silicon grain in a vacuum, as shown in drawing 3 (a), the crystalline good polycrystalline silicon ball 11 is formed, and n mold polycrystalline silicon layer 12 is formed in this front face with the CVD method using mixed gas, such as a silane containing phosphoretted hydrogen. A CVD process performs thin film formation here by carrying out supply blowdown of the gas heated by desired reaction temperature, conveying a silicon ball within a thin tube. In addition, this process can also form n mold polycrystalline silicon layer 12 by making desired gas contact on the way of [drop] while it spheroidizes making it fall heating p mold polycrystalline silicon grain or p mold amorphous silicon grain in a vacuum and forms p mold polycrystalline silicon ball.

[0035] Then, as shown in drawing 3 (b), the ITO thin film 13 of about 1 micrometer of thickness is formed in the whole substrate front face by the sputtering method.

[0036] Thus, as shown in drawing 4 (a), after covering Tray T with the formed photovoltaic cell 1 at a single tier, the tray T of this is made to slush and harden a wax 10.

[0037] And as shown in drawing 4 (b), this base is positioned, and a spherical cel is cut from a core by Dicer DS so that it may divide in right in the middle.

[0038] Then, as shown in drawing 4 (c), a cutting plane is stuck on the polyimide tape 7. And said wax 10 is removed, fixed seven times on said polyimide tape, as shown in drawing 4 (d).

[0039] Furthermore, as shown in drawing 5 (a), two or more cels stuck on the polyimide tape 7 are horizontally arranged so that said cel may be located upwards, polyimide resin fine-particles 4p is sprinkled from the top face of said cel, said cel is heated, and between said cels and cels is fixed in the polyimide resin layer 4.

[0040] Then, [0041] which sprinkles solder fine-particles 3p from the top face of said cel, heats said cel, liquefies said solder fine-particles 3p, fixes between the ground electrodes 13 of said cel in the solder layer 3, and carries out exfoliation clearance of the polyimide tape 7 as shown in drawing 5 (b) And as shown in drawing 5 (c), p mold impurity is poured in from the rear-face side of a hemisphere, and 11s of high concentration layers is formed.

[0042] And as shown in drawing 5 (d), the electric conduction plate 5 is stuck so that 11s of this high concentration layer may be contacted, and the protective coat 7 which consists of polyimide film further is formed.

[0043] Thus, a photovoltaic cell as shown in drawing 1 and drawing 2 is completed.

[0044] It becomes possible extremely by fixing with a sufficient location precision and cutting this collectively to obtain a hemisphere to high degree of accuracy by making it align in the maximum dense arrangement condition, where a tray is covered with the sphere in which pn junction and a ground electrode were formed according to this configuration, and hardening this by resin.

[0045] And a hemisphere can be obtained in the condition of having aligned at high degree of accuracy, by fixing a cutting plane on a tape etc. after cutting, and removing resin. And after forming a high concentration layer in this, by forming the electric conduction plate as an inside electrode, the efficient solar battery which consists of a hemisphere by which the maximum dense arrangement was carried out can be formed with sufficient productivity.

[0046] Since the two divided aggregates are used as every one solar battery, respectively, there is no futility in an ingredient and they become what also has very high productivity further again.

[0047] Moreover, according to this approach, a mask process is unnecessary. Although an exposure process is very difficult for especially the photolithography process to a spherule, according to the approach of this invention, it becomes possible to form a very efficient solar battery, without needing a photolithography process.

[0048] Moreover, since the connection resilience between hemispheres is raised with the solder layer while fusing solder powder further and fixing both photovoltaic cells, and it is made to perform electrical installation between ground electrodes and a resin layer contributes to the insulation with an electric conduction plate and a ground electrode after fusing the resin included in the clearance between the cels which constitute a solar battery and fixing in a resin layer, a reliable solar battery can be obtained.

[0049] Although a hemisphere [a little] smaller than a semi-sphere is formed with the cutting waste in a cutting process, few gaps are formed between hemispheres by this, and when resin enters this gap, the effectiveness that the insulation with the electric conduction plate used as a ground electrode and an inside electrode becomes a positive thing also takes effect further again.

[0050] Furthermore, since a high concentration field is formed between an electric conduction plate and p mold polycrystalline silicon, contact nature will become high. Moreover, a photolithography process is

unnecessary even if it faces formation of this high concentration layer.
[0051] Although the photovoltaic cell was constituted from an operation gestalt of the operation gestalt 2 above 1st using p mold polycrystalline silicon ball As shown in drawing 6 , the spherical substrate 10 is constituted from a copper ball. On a spherical substrate front face Amorphous silicon layer 11a of p mold, It is characterized by removing a ground electrode 13, the polycrystalline silicon layer 12 of n mold, and a part of p mold amorphous silicon layer 11a so that n mold polycrystalline silicon layer 12 may be formed, it may come to form pn junction and the electric conduction sheet 5 may contact said copper ball.
[0052] According to this configuration, contact resistance of an inside electrode becomes possible [forming a low reliable solar battery easily]. Although the polycrystalline silicon layer was used as an n type layer in said example, it cannot be overemphasized that an amorphous silicon layer may be used.
[0053] In addition, the series connection of the photovoltaic cell may be carried out, and it may carry out parallel connection. In case a series connection is carried out, it is also possible to form a series-connection object by arranging by turns the cel which made p layers and n layers reverse by the outside surface and inner surface side, and connecting similarly.
[0054] Although the photovoltaic cell which even the ground electrode formed using p mold polycrystalline silicon ball was unified with the wax and cut to the semi-sphere with the operation gestalt of the operation gestalt 3 above 1st, a wax 10 is removed, after unifying with a wax by the approach same with the polycrystalline silicon ball 11 having been shown in drawing 3 with the raw material, dividing to a semi-sphere and fixing in one on the polyimide tape 7, as shown in drawing 7 (a) thru/or (d).
[0055] As shown in after [this] drawing 8 (a), p mold polycrystalline silicon semi-sphere 11 stuck on the polyimide tape is horizontally arranged so that p mold polycrystalline silicon semi-sphere 11 may be located upwards, polyimide resin fine-particles 4p is sprinkled and heated from a top face, and between p mold polycrystalline silicon semi-spheres 11 is fixed in the polyimide resin layer 4.
[0056] Then, as shown in drawing 8 (b), by impurity diffusion, Lynn is diffused and n mold polycrystalline silicon layer 12 is formed. Impurity diffusion is performed here by carrying out supply blowdown of the gas heated by desired reaction temperature, conveying a silicon ball within a thin tube. Then, the ITO thin film 13 of about 1 micrometer of thickness is formed in the whole substrate front face by the sputtering method.
[0057] And [0058] which sprinkles and heats solder fine-particles 3p from the top face of p mold polycrystalline silicon semi-sphere 11 in which even the ground electrode 13 was formed, liquefies said solder fine-particles 3p, fixes between the ground electrodes 13 of a cel in the solder layer 3, and carries out exfoliation clearance of the polyimide tape 7 as shown in drawing 8 (c) And as shown in drawing 8 (d), p mold impurity is poured in from the rear-face side of a hemisphere, and 11s of high concentration layers is formed.
[0059] And as shown in drawing 8 (e), the electric conduction plate 5 is stuck so that 11s of this high concentration layer may be contacted, and the protective coat 7 which consists of polyimide film further is formed. Thus, a photovoltaic cell is completed. It carries out and a solar battery is completed.
[0060] By this approach, it becomes possible beforehand between p mold polycrystalline silicon semi-spheres 11 to form a more reliable solar battery, since a resin layer can be made to be able to intervene and insulating separation can be carried out. Moreover, since 11s of high concentration layers is formed, the back sir FISU field effectiveness can be acquired.
[0061] In addition, although an amorphous silicon and polycrystalline silicon were used with the gestalt of said operation as a semi-conductor layer which forms pn junction, it can apply to a single-crystal-silicon layer and a pan also at compound semiconductor layers, such as GaAs and GaP, without being limited to this. Furthermore, it is applicable not only to pn structure but pin structure.
[0062] Since it is possible to connect and line-ize each down stream processing on the occasion of manufacture of this spherical semiconductor device, there is the description that productivity is very high.
[0063] At each process, processing in the various ambient atmospheres not only containing gases, such as activated gas and inert gas, but liquids, such as water and various solutions, is made. When connecting such down stream processing, in order to have to make it not have to bring the ambient atmosphere which conveys a processed material to an after process from a before process, Although the ambient atmosphere of a before process is removed from a processed material between processes and the activity of changing into the ambient atmosphere doubled with the after process, and conveying a processed material is required Each down stream processing can be performed conveying by using an ambient atmosphere inverter, and it becomes possible extremely to offer a reliable semiconductor device with sufficient workability at high speed.
[0064] Moreover, although said example explained the manufacture approach of a solar battery, it cannot be overemphasized that the cutting process of a ball can be applied not only to cutting of a semi-conductor ball but to insulating materials, such as a bulb.

[0065]
[Effect of the Invention] As explained above, according to this invention, it becomes possible very easily to form the semi-sphere of high degree of accuracy with sufficient productivity. Moreover, positioning becomes it is unnecessary, pack density is also high, and it is efficient, and possible [offering a reliable solar battery].
[0066] Moreover, arrangement of high density is possible, without decreasing light-receiving area. Moreover, without using a photolithography process, it is highly precise and a reliable solar battery can be obtained. Moreover, it becomes possible to attain low cost-ization.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention] This invention relates to cutting process, the spherical solar battery using this, and its spherical manufacture approach, and relates to the solar battery especially using a hemispherical semiconductor.

[Translation done.]

1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

PRIOR ART

[Description of the Prior Art] The electron and electron hole which were generated when the internal field has arisen into the pn junction part of a semi-conductor, light is applied to this and the electron-hole pair was made to generate are separated by the internal field, an electron is brought together in the n side, an electron hole is brought together in the p side, and if a load is connected outside, a current will flow towards the n side from the p side. This effectiveness is used and utilization of a solar battery is advanced as a component which transforms light energy into electrical energy.
[0003] In recent years, the technique of forming a circuit pattern on a spherical semi-conductor (Ball Semiconductor) with a diameter [of single crystal silicon polycrystalline silicon, etc.] of 1mm or less, and manufacturing a semiconductor device is developed.
[0004] The manufacture approach of the solar array which connected many semi-conductor particles, using aluminum foil as one is proposed (JP,6-13633,A). By this approach, as shown in drawing 9 , the semi-conductor particle 207 which has the 1st conductivity-type epidermis section and the interior of the 2nd conductivity type is arranged so that it may project from the both sides of aluminum foil 201 in opening of aluminum foil, the epidermis section 209 of one side is removed, and an insulating layer 221 is formed. Next, the part inside [111] the 2nd conductivity type and the insulating layer 221 on it are removed, and the 2nd aluminum foil 219 is combined with the removed field 217. The flat field 217 offers good ohmic contact to the 2nd aluminum foil 219 as a current carrying part.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] As explained above, according to this invention, it becomes possible very easily to form the semi-sphere of high degree of accuracy with sufficient productivity. Moreover, positioning becomes it is unnecessary, pack density is also high, and it is efficient, and possible [offering a reliable solar battery].
[0066] Moreover, arrangement of high density is possible, without decreasing light-receiving area. Moreover, without using a photolithography process, it is highly precise and a reliable solar battery can be obtained. Moreover, it becomes possible to attain low cost-ization.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, by such approach, there was a limitation in high density arrangement, and positioning to aluminum foil was difficult, and when many semi-conductor particles were mounted, there was a problem that especially workability was bad.
[0006] Moreover, although the contact terminal the 1st conductivity-type epidermis section and inside [both] the 2nd conductivity type was required also about formation of an electrode, there was a problem that it was difficult to form a positive contact terminal, without decreasing light-receiving area.
[0007] Some outside fields were removed by approaches, such as polish, further again, although the approach of forming an electrode in the exposed field was proposed, by such approach, the diffusion layer of a different conductivity type lived together in the same field, and there was a problem that it was difficult to take these out independently.
[0008] Furthermore, in case a hemispherical substrate was formed, positioning was very difficult and cutting of high degree of accuracy was impossible.
[0009] This invention was made in view of said actual condition, and is reliable, and it aims at offering the possible solar battery of a miniaturization.
[0010] Moreover, contact formation is easy and this invention aims to let it offer the small solar battery of dispersion in a property.
[0011] Moreover, this invention aims at offering a scale and an efficient solar battery for improvement in the electromotive force per unit area. Furthermore, this invention aims at cutting a sphere efficiently to high degree of accuracy.

[Translation done.]

MEANS

[Means for Solving the Problem] It is the process to which the 1st covers a tray with the sphere of this invention at a single tier. The process which is filled up with resin in said tray, is made to harden with the sphere with which it was covered, and fixes many spheres in one, It is characterized by including the process cut with resin so that the cutting plane which positions in the condition of having fixed by resin and passes along each spherical core may be formed, the process which sticks a tape on this cutting plane, and the process which removes said resin, fixed on said tape, and forms a hemisphere.
[0013] It becomes possible by according to this configuration, making it align in the maximum dense arrangement condition, where a tray is covered with a sphere, and hardening this by resin to cut to high degree of accuracy extremely by fixing with a sufficient location precision and cutting this collectively.
[0014] And a hemisphere can be obtained in the state of alignment by fixing a cutting plane on a tape etc. after cutting, and removing resin. In addition, the semi-conductor ball element assembly itself, such as a single-crystal-silicon ball or a polycrystalline silicon ball, is sufficient as such a hemisphere, and the semiconductor device which semiconductor devices, such as diode, made and was full is sufficient as it.
[0015] The semi-conductor layer of the 2nd conductivity type formed so that pn junction might be formed in the spherical substrate front face on which a front face constitutes the semi-conductor layer of the 1st conductivity type at least according to the 2nd of this invention, The process which prepares many cels in which the ground electrode which consists of transparence electric conduction film formed in said 2nd semi-conductor layer front face was formed, The process which covers a single tier with said cel at a tray, and the process which is filled up with resin in said tray, is made to harden with the cel with which it was covered, and fixes many photovoltaic cells in one, The process cut with resin so that the cutting plane which positions in the condition of having fixed by resin and passes along the core of each cel may be formed, It is characterized by including the process which sticks a tape on this cutting plane, and the process which forms an electrode so that said resin may be removed fixed on said tape and the semi-conductor layer of said 1st conductivity type may be contacted.
[0016] It becomes possible extremely by fixing with a sufficient location precision and cutting this collectively to obtain a hemisphere to high degree of accuracy by making it align in the maximum dense arrangement condition, where a tray is covered with the sphere in which pn junction and a ground electrode were formed according to this configuration, and hardening this by resin.
[0017] And a hemisphere can be obtained in the condition of having aligned at high degree of accuracy, by fixing a cutting plane on a tape etc. after cutting, and removing resin. And by forming the electric conduction plate as an inside electrode in this, the efficient solar battery which consists of a hemisphere by which the maximum dense arrangement was carried out can be formed with sufficient productivity.
[0018] Since the two divided aggregates are used as every one solar battery, respectively, there is no futility in an ingredient and they become what also has very high productivity further again.
[0019] Moreover, according to this approach, a mask process is unnecessary. Although an exposure process is very difficult for especially the photolithography process to a spherule, according to the approach of this invention, it becomes possible to form a very efficient solar battery, without needing a photolithography process.
[0020] The semi-conductor layer of the 2nd conductivity type formed so that pn junction might be formed in the spherical substrate front face on which a front face constitutes the semi-conductor layer of the 1st conductivity type at least according to the 3rd of this invention, The process which prepares many cels in which the ground electrode which consists of transparence electric conduction film formed in said 2nd semi-conductor layer front face was formed, The process which covers a single tier with said cel at a tray, and the process which is filled up with resin in said tray, is made to harden with the cel with which it was covered, and fixes many photovoltaic cells in one, The process cut with resin so that the cutting plane

which positions in the condition of having fixed by resin and passes along the core of each cel may be formed, It has fixed on the process which sticks a tape on this cutting plane, and said tape. The process which arranges horizontally two or more cels which removed said resin and were stuck on said tape so that said cel may be located upwards, The process which sprinkles resin fine particles from the top face of said cel, and the process which heats said cel and fixes between said cels and said tapes in a resin layer, It is characterized by including the process which furthermore sprinkles solder fine particles, the process which heats said cel, liquefies said solder fine particles, and fixes between said cels and said tapes with solder, and the process which removes said tape and fixes an electric conduction plate.

[0021] According to this configuration, in addition to said 2nd effectiveness, the resin included in the clearance between the cels which constitute a solar battery is fused. After fixing in a resin layer, while fusing solder powder further, fixing both photovoltaic cells and . which is made to perform electrical installation between ground electrodes, therefore a resin layer contribute to the insulation with an electric conduction plate and a ground electrode Since the connection resilience between hemispheres is raised with the solder layer, a reliable solar battery can be obtained.

[0022] Although a hemisphere [a little] smaller than a semi-sphere is formed with the cutting waste in a cutting process, few gaps are formed between hemispheres by this, and when resin enters this gap, the effectiveness that the insulation with the electric conduction plate used as a ground electrode and an inside electrode becomes a positive thing also takes effect further again.

[0023] According to the 4th of this invention, it is characterized by including the process which dopes the high-concentration 1st conductivity-type impurity from the rear-face side of said semi-sphere in advance of the process which fixes said electric conduction plate.

[0024] According to this configuration, since a high concentration field is formed between an electric conduction plate and the 1st conductivity-type semi-conductor layer, contact nature will become high. Moreover, when the back sir FISU field effectiveness can also take effect, on the occasion of formation of this high concentration layer, a photolithography process is unnecessary.

[0025] According to the 5th of this invention, in the manufacture approach of a solar battery according to claim 4, it is characterized by including further the process which forms a protective coat on said electric conduction plate.

[0026] According to this configuration, dependability improves by existence of a protective coat.

[0027] The hemispherical substrate with which a front face constitutes the semi-conductor layer of the 1st conductivity type at least according to the 6th solar battery of this invention, The semi-conductor of the 2nd conductivity type formed so that pn junction might be formed in said ball front face, The electric conduction plate as the ground electrode which consists of transparence electric conduction film formed in said 2nd semi-conductor layer front face, and an inside electrode formed in the base of said hemispherical substrate is provided, and it is characterized by making insulating resin intervene between the edge of said ground electrode, and said electric conduction plate.

[0028] According to this configuration, light-receiving effectiveness becomes possible [obtaining a high solar battery with high luminous efficiency] with the minimum ingredient.

[0029] The hemispherical substrate with which a front face constitutes the semi-conductor layer of the 1st conductivity type at least with the electric conduction plate as an inside electrode according to the 7th of this invention, The semi-conductor layer of the 2nd conductivity type formed so that pn junction might be formed in said ball front face, It is arranged so that two or more semi-sphere cels which come to provide the ground electrode which consists of transparence electric conduction film formed in said 2nd semi-conductor layer front face may touch said electric conduction plate front face in the base. A conductor layer is formed in the field located between said cels of said electric conduction plate front face through insulating resin, and it is characterized by making the electrical installation of said ground electrodes through this conductor layer. According to this configuration, dimensional accuracy can obtain the solar battery of the maximum dense arrangement structure highly.

[0030] Moreover, an insulating layer will intervene between the electric conduction plates by the side of a ground electrode and an inside electrode, there is also no fear of a short circuit, and it becomes possible to form a reliable solar battery.

[0031] According to the 8th of this invention, in a solar battery according to claim 7, said hemispherical substrate consists of a silicon ball of the 1st conductivity type, and is characterized by coming to form pn junction between the silicon layers of the 2nd conductivity type formed in the front face of said silicon ball.

[0032] According to the 9th of this invention, in a solar battery according to claim 7, said hemispherical substrate consists of a metal spherule, form in the ball front face of said hemispherical object the silicon layer of the 1st conductivity type, and the silicon layer of the 2nd conductivity type formed in the silicon layer front face of said 1st conductivity type, it comes to form pn junction, and said electric conduction

plate is characterized by being formed so that the base of said hemisphere may be contacted.
[0033]
[Embodiment of the Invention] Next, it explains to a detail, referring to a drawing about the gestalt of operation of this invention.
The solar battery of the 1st operation gestalt of operation gestalt 1 this invention As general drawing is shown in drawing 1 and a cross-section schematic diagram is shown in drawing 2 , the photovoltaic cell 1 which consists of hemispherical silicon The maximum dense array is carried out on the electric conduction plate 5 which consists of a copper plate as an inside electrode, it is made to fix a base, and electrical installation and immobilization are made by the solder layer 3 by which the ground electrode was formed in the field between the cels 1 on the electric conduction plate 5 through the resin layer 4. Namely, the hemispherical substrate 11 which consists of single crystal silicon of p mold and n mold polycrystalline silicon layer 12 formed so that pn junction might be formed in the ball front face of said hemispherical substrate, It is arranged so that two or more semi-sphere cels which come to provide the ground electrode 13 of the transparence which consists of indium oxide tin (ITO) formed in n mold polycrystalline silicon layer 12 front face may touch said electric conduction plate 5 front face in the base. The solder layer 3 is formed in the field located between said cels of said electric conduction plate 5 front face through the insulating resin layer 4, and the electrical installation of said ground-electrode 13 comrades is made through this solder layer 3.
[0034] Next, the manufacture approach of this solar battery is explained. First, a photovoltaic cell is formed. It is made to fall, heating p mold polycrystalline silicon grain with a diameter of 1mm or p mold amorphous silicon grain in a vacuum, as shown in drawing 3 (a), the crystalline good polycrystalline silicon ball 11 is formed, and n mold polycrystalline silicon layer 12 is formed in this front face with the CVD method using mixed gas, such as a silane containing phosphoretted hydrogen. A CVD process performs thin film formation here by carrying out supply blowdown of the gas heated by desired reaction temperature, conveying a silicon ball within a thin tube. In addition, this process can also form n mold polycrystalline silicon layer 12 by making desired gas contact on the way of [drop] while it spheroidizes making it fall heating p mold polycrystalline silicon grain or p mold amorphous silicon grain in a vacuum and forms p mold polycrystalline silicon ball.
[0035] Then, as shown in drawing 3 (b), the ITO thin film 13 of about 1 micrometer of thickness is formed in the whole substrate front face by the sputtering method.
[0036] Thus, as shown in drawing 4 (a), after covering Tray T with the formed photovoltaic cell 1 at a single tier, the tray T of this is made to slush and harden a wax 10.
[0037] And as shown in drawing 4 (b), this base is positioned, and a spherical cel is cut from a core by Dicer DS so that it may divide in right in the middle.
[0038] Then, as shown in drawing 4 (c), a cutting plane is stuck on the polyimide tape 7. And said wax 10 is removed, fixed seven times on said polyimide tape, as shown in drawing 4 (d).
[0039] Furthermore, as shown in drawing 5 (a), two or more cels stuck on the polyimide tape 7 are horizontally arranged so that said cel may be located upwards, polyimide resin fine-particles 4p is sprinkled from the top face of said cel, said cel is heated, and between said cels and cels is fixed in the polyimide resin layer 4.
[0040] Then, [0041] which sprinkles solder fine-particles 3p from the top face of said cel, heats said cel, liquefies said solder fine-particles 3p, fixes between the ground electrodes 13 of said cel in the solder layer 3, and carries out exfoliation clearance of the polyimide tape 7 as shown in drawing 5 (b) And as shown in drawing 5 (c), p mold impurity is poured in from the rear-face side of a hemisphere, and 11s of high concentration layers is formed.
[0042] And as shown in drawing 5 (d), the electric conduction plate 5 is stuck so that 11s of this high concentration layer may be contacted, and the protective coat 7 which consists of polyimide film further is formed.
[0043] Thus, a photovoltaic cell as shown in drawing 1 and drawing 2 is completed.
[0044] It becomes possible extremely by fixing with a sufficient location precision and cutting this collectively to obtain a hemisphere to high degree of accuracy by making it align in the maximum dense arrangement condition, where a tray is covered with the sphere in which pn junction and a ground electrode were formed according to this configuration, and hardening this by resin.
[0045] And a hemisphere can be obtained in the condition of having aligned at high degree of accuracy, by fixing a cutting plane on a tape etc. after cutting, and removing resin. And after forming a high concentration layer in this, by forming the electric conduction plate as an inside electrode, the efficient solar battery which consists of a hemisphere by which the maximum dense arrangement was carried out can be formed with sufficient productivity.
[0046] Since the two divided aggregates are used as every one solar battery, respectively, there is no

futility in an ingredient and they become what also has very high productivity further again.
[0047] Moreover, according to this approach, a mask process is unnecessary. Although an exposure process is very difficult for especially the photolithography process to a spherule, according to the approach of this invention, it becomes possible to form a very efficient solar battery, without needing a photolithography process.
[0048] Moreover, since the connection resilience between hemispheres is raised with the solder layer while fusing solder powder further and fixing both photovoltaic cells, and it is made to perform electrical installation between ground electrodes and a resin layer contributes to the insulation with an electric conduction plate and a ground electrode after fusing the resin included in the clearance between the cels which constitute a solar battery and fixing in a resin layer, a reliable solar battery can be obtained.
[0049] Although a hemisphere [a little] smaller than a semi-sphere is formed with the cutting waste in a cutting process, few gaps are formed between hemispheres by this, and when resin enters this gap, the effectiveness that the insulation with the electric conduction plate used as a ground electrode and an inside electrode becomes a positive thing also takes effect further again.
[0050] Furthermore, since a high concentration field is formed between an electric conduction plate and p mold polycrystalline silicon, contact nature will become high. Moreover, a photolithography process is unnecessary even if it faces formation of this high concentration layer.
[0051] Although the photovoltaic cell was constituted from an operation gestalt of the operation gestalt 2 above 1st using p mold polycrystalline silicon ball As shown in drawing 6 , the spherical substrate 10 is constituted from a copper ball. On a spherical substrate front face Amorphous silicon layer 11a of p mold, It is characterized by removing a ground electrode 13, the polycrystalline silicon layer 12 of n mold, and a part of p mold amorphous silicon layer 11a so that n mold polycrystalline silicon layer 12 may be formed, it may come to form pn junction and the electric conduction sheet 5 may contact said copper ball.
[0052] According to this configuration, contact resistance of an inside electrode becomes possible [forming a low reliable solar battery easily]. Although the polycrystalline silicon layer was used as an n type layer in said example, it cannot be overemphasized that an amorphous silicon layer may be used.
[0053] In addition, the series connection of the photovoltaic cell may be carried out, and it may carry out parallel connection. In case a series connection is carried out, it is also possible to form a series-connection object by arranging by turns the cel which made p layers and n layers reverse by the outside surface and inner surface side, and connecting similarly.
[0054] Although the photovoltaic cell which even the ground electrode formed using p mold polycrystalline silicon ball was unified with the wax and cut to the semi-sphere with the operation gestalt of the operation gestalt 3 above 1st, a wax 10 is removed, after unifying with a wax by the approach same with the polycrystalline silicon ball 11 having been shown in drawing 3 with the raw material, dividing to a semi-sphere and fixing in one on the polyimide tape 7, as shown in drawing 7 (a) thru/or (d).
[0055] As shown in after [this] drawing 8 (a), p mold polycrystalline silicon semi-sphere 11 stuck on the polyimide tape is horizontally arranged so that p mold polycrystalline silicon semi-sphere 11 may be located upwards, polyimide resin fine-particles 4p is sprinkled and heated from a top face, and between p mold polycrystalline silicon semi-spheres 11 is fixed in the polyimide resin layer 4.
[0056] Then, as shown in drawing 8 (b), by impurity diffusion, Lynn is diffused and n mold polycrystalline silicon layer 12 is formed. Impurity diffusion is performed here by carrying out supply blowdown of the gas heated by desired reaction temperature, conveying a silicon ball within a thin tube. Then, the ITO thin film 13 of about 1 micrometer of thickness is formed in the whole substrate front face by the sputtering method.
[0057] And [0058] which sprinkles and heats solder fine-particles 3p from the top face of p mold polycrystalline silicon semi-sphere 11 in which even the ground electrode 13 was formed, liquefies said solder fine-particles 3p, fixes between the ground electrodes 13 of a cel in the solder layer 3, and carries out exfoliation clearance of the polyimide tape 7 as shown in drawing 8 (c) And as shown in drawing 8 (d), p mold impurity is poured in from the rear-face side of a hemisphere, and 11s of high concentration layers is formed.
[0059] And as shown in drawing 8 (e), the electric conduction plate 5 is stuck so that 11s of this high concentration layer may be contacted, and the protective coat 7 which consists of polyimide film further is formed. Thus, a photovoltaic cell is completed. It carries out and a solar battery is completed.
[0060] By this approach, it becomes possible beforehand between p mold polycrystalline silicon semi-spheres 11 to form a more reliable solar battery, since a resin layer can be made to be able to intervene and insulating separation can be carried out. Moreover, since 11s of high concentration layers is formed, the back sir FISU field effectiveness can be acquired.
[0061] In addition, although an amorphous silicon and polycrystalline silicon were used with the gestalt of said operation as a semi-conductor layer which forms pn junction, it can apply to a single-crystal-silicon

layer and a pan also at compound semiconductor layers, such as GaAs and GaP, without being limited to this. Furthermore, it is applicable not only to pn structure but pin structure.
[0062] Since it is possible to connect and line-ize each down stream processing on the occasion of manufacture of this spherical semiconductor device, there is the description that productivity is very high.
[0063] At each process, processing in the various ambient atmospheres not only containing gases, such as activated gas and inert gas, but liquids, such as water and various solutions, is made. When connecting such down stream processing, in order to have to make it not have to bring the ambient atmosphere which conveys a processed material to an after process from a before process, Although the ambient atmosphere of a before process is removed from a processed material between processes and the activity of changing into the ambient atmosphere doubled with the after process, and conveying a processed material is required Each down stream processing can be performed conveying by using an ambient atmosphere inverter, and it becomes possible extremely to offer a reliable semiconductor device with sufficient workability at high speed.
[0064] Moreover, although said example explained the manufacture approach of a solar battery, it cannot be overemphasized that the cutting process of a ball can be applied not only to cutting of a semi-conductor ball but to insulating materials, such as a bulb.

[Translation done.]

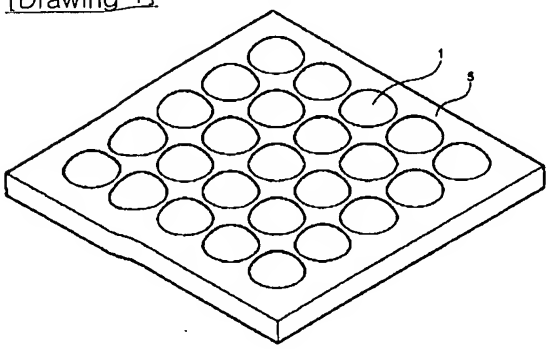
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Drawing showing the solar battery of the 1st operation gestalt of this invention
[Drawing 2] The sectional view of the cel which constitutes the solar battery of the 1st operation gestalt of this invention
[Drawing 3] Production process drawing of the cel which constitutes the solar battery of the 1st operation gestalt of this invention
[Drawing 4] Drawing showing the mounting process of the solar battery of the 1st operation gestalt of this invention
[Drawing 5] Drawing showing the mounting process of the solar battery of the 1st operation gestalt of this invention
[Drawing 6] Drawing showing the solar battery of the 2nd operation gestalt of this invention
[Drawing 7] Drawing showing the production process of the solar battery of the 3rd operation gestalt of this invention
[Drawing 8] Drawing showing the production process of the solar battery of the 3rd operation gestalt of this invention
[Drawing 9] Drawing showing the solar battery of the conventional example
[Description of Notations]
1 Solar Battery
3 Solder Layer
4 Resin Layer
5 Conductor Layer
7 Polyimide Tape (Protective Coat)
11 P Mold Polycrystalline Silicon Ball
12 N Mold Polycrystalline Silicon Layer
13 Ground Electrode

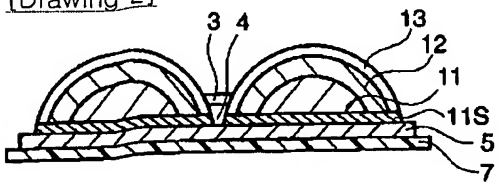
[Translation done.]

DRAWINGS

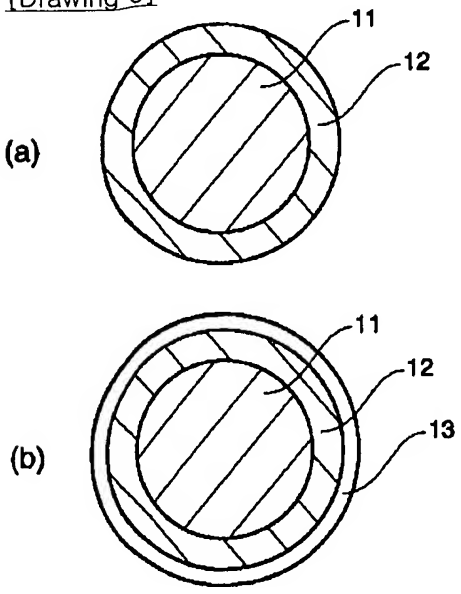
[Drawing 1]



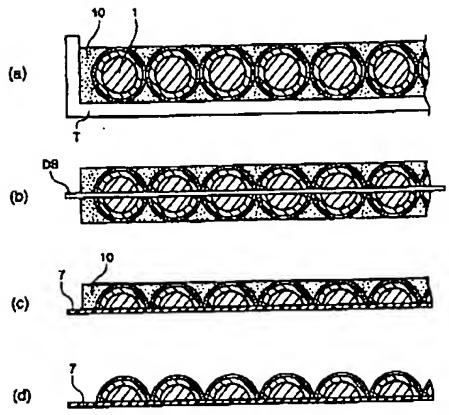
[Drawing 2]



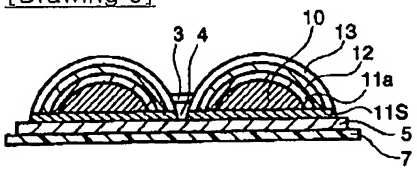
[Drawing 3]



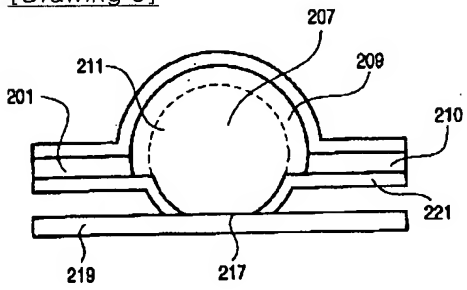
[Drawing 4]



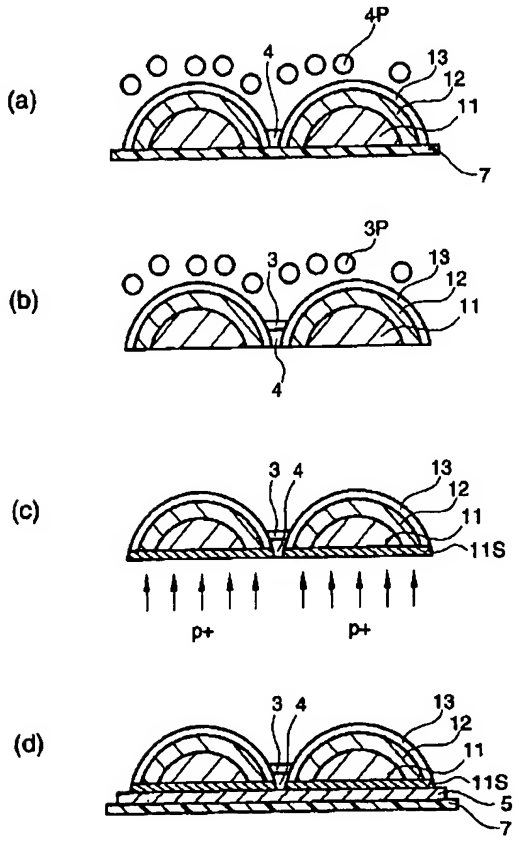
[Drawing 6]



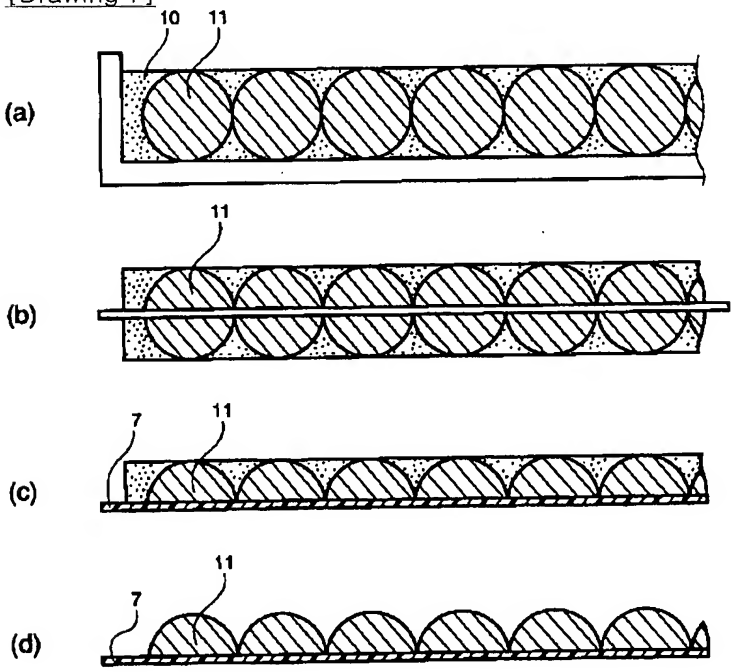
[Drawing 9]



[Drawing 5]

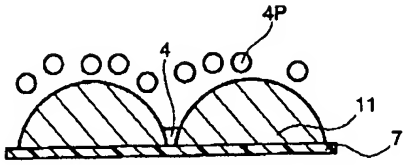


[Drawing 7]

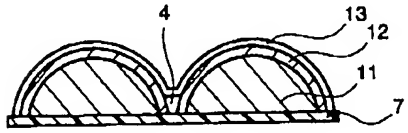


[Drawing 8]

(a)



(b)



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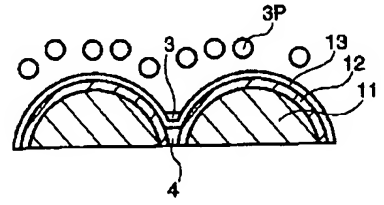
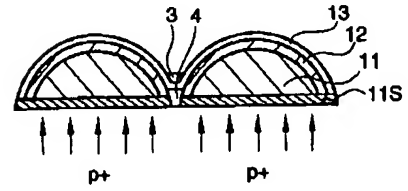


(d)



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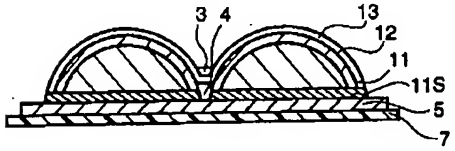

[Translation done.]